PHYS 227 E&M II

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Canvas site up (syllabus + learning goals)

Midterm Wed. May 4^{th}

setup ED for QED

fields indpt. of sources. interaction + dynamics
→ radiation

not 100% Griffiths (for example, antennas) skip wave guides

Correcting Electrostatic Assumptions

Faraday: $\vec{\nabla}\times\vec{E} = -\frac{\partial \vec{B}}{\partial t} = -\partial_t \vec{B}$

Ampere: $\vec{\nabla}\times\vec{B} = \mu_0 \vec{J}$

$\vec{\nabla}\cdot(\vec{\nabla}\times\vec{E}) = 0 = -\vec{\nabla}(\partial_t \vec{B}) = -\partial_t(\vec{\nabla}\cdot\vec{B}) = -\partial_t(0)$ → 0 magnetic monopoles

$\vec{\nabla}\cdot(\vec{\nabla}\times\vec{B}) = 0 = \mu_0(\vec{\nabla}\cdot\vec{J}) = \mu_0(-\partial_t \rho)$ Spewing out $\vec{J}$, continuity eq^{n}

Gauss: $\vec{\nabla}\cdot\vec{E} = \frac{\rho}{\epsilon_0}$

$\partial_t(\vec{\nabla}\cdot\vec{E}) = \partial_t\left(\frac{\rho}{\epsilon_0}\right) = \frac{1}{\epsilon_0}\cdot(-\vec{\nabla}\cdot\vec{J})$

$-\epsilon_0\,\vec{\nabla}\cdot(\partial_t\vec{E}) = \vec{\nabla}\cdot\vec{J}$

spatial & time spatial

→ $-\epsilon_0\partial_t\vec{E} = \vec{J}$

$\vec{J}$ flowing somewhere
$\vec{E}$ changing w/ t

Change Ampere's Law!

$\vec{\nabla}\times\vec{B} = \mu_0\vec{J}$ but inconsistent

① write sum
② consistent
③ broad view → physical interpretation

okay, say we didn't account all $\vec{J}$, $\vec{J} \equiv \vec{J}_{tot} = \vec{J}_1 + \vec{J}_2 = \vec{J}_{steady} + \vec{J}_{displacement}$ — missed time dependence

$\vec{\nabla}\times\vec{B} = \mu_0(\vec{J}_{steady} + \vec{J}_{displ.}) = \mu_0\vec{J}_{steady} + \mu_0\epsilon_0\frac{\partial \vec{E}}{\partial t}$

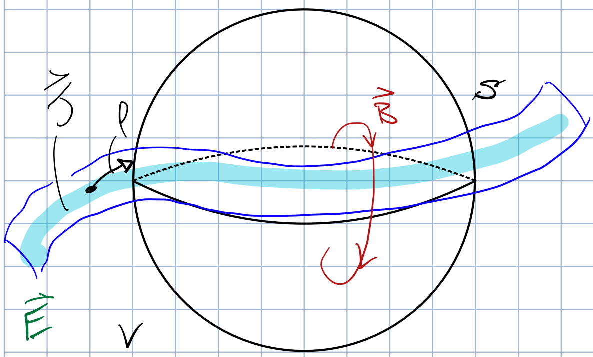
same thing, take divergences

$$\vec\nabla\cdot(\vec\nabla\times\vec B)=0 = \mu_0(\vec\nabla\cdot\vec J_{steady}) + \mu_0\epsilon_0(\vec\nabla\,\partial_t\vec E)$$

$$0 = \mu_0(\vec\nabla\cdot\vec J_{steady}) + \mu_0\epsilon_0\,\partial_t(\vec\nabla\cdot\vec E)$$

Volume integral $\{\int$ ... goes

$$0 = \mu_0(-\partial_t\rho) + \mu_0(\partial_t\rho)$$



whats curl of $\vec B$ w/ $\vec J$?

need $\vec E$ to <u>drive</u> $\vec J$

previously assumed no dynamics

now fields will do things

$\vec J_{disp}$ created by varying $\vec E$ created by varying $\vec B$

Complete Maxwell's Eq^ns

$$\vec\nabla\cdot\vec E = \rho/\epsilon_0 \qquad \vec\nabla\times\vec E = -\partial_t\vec B$$

$$\vec\nabla\cdot\vec B = 0 \qquad \vec\nabla\times\vec B = \epsilon_0\mu_0\,\partial_t\vec E + \mu_0\vec J$$

patterns!

need "source" terms

need both $\vec B$ & $\vec E$